June 2, 1936. W. F. WESTENDORP 2,043,023

CIRCUITS AND APPARATUS FOR OPERATING ELECTRIC DISCHARGE LAMPS

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Fig. 1

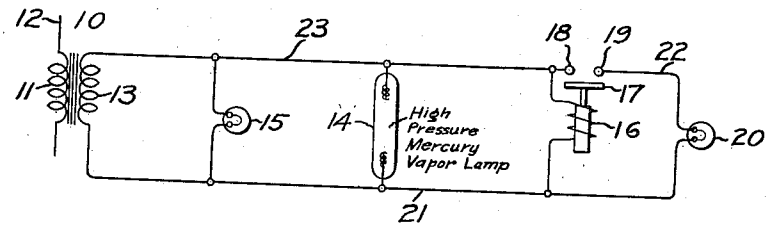


Fig. 2

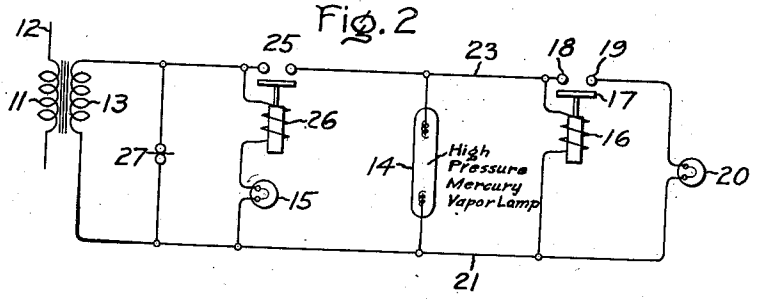
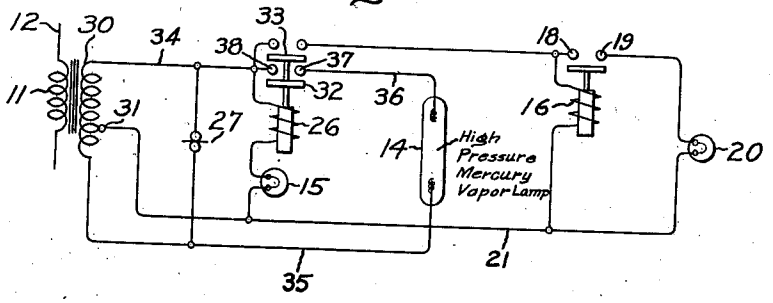


Fig. 3



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CIRCUITS AND APPARATUS FOR OPERATING ELECTRIC DISCHARGE LAMPS

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5 Claims. (Cl. 176—9)

My invention relates to electric-discharge lamps, and more particularly to a circuit and apparatus for operating them.

One object of my invention is to provide an improved circuit and apparatus for regulating the voltage and current in a series operated discharge lamp throughout the starting and operating period.

Another object of my invention is to provide means for converting into light the available energy not used by the discharge lamp during its operating period.

For a better understanding of my invention, together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a schematic diagram illustrating my invention, and Figs. 2 and 3 are modifications thereof.

Referring to Fig. 1 in detail, a transformer 10 provided with a primary winding 11, is connected into a constant current series circuit 12. A secondary winding 13 of this transformer supplies current to an electric-discharge lamp 14 and an incandescent filament lamp 15 in multiple. A relay coil 16 is also connected in multiple with the lamps 14 and 15 and operates a contact bar 17. When this coil is sufficiently energized, it operates this contact bar 17 to close a circuit across a pair of contacts 18 and 19, thereby closing a circuit to a second lamp 20.

The electric-discharge lamp 14 is of the type described in United States Patent 1,948,261, assigned to the assignee of the present invention. In this type of lamp a metal vapor, such as mercury, for example, is used, which during operation of the lamp rises to a pressure substantially equal to atmospheric pressure, and the lamp is, therefore, usually referred to as high pressure mercury vapor lamp. Among the characteristics of this type of lamp are a high current and comparatively low voltage at starting approximately 5 amperes at 20 volts, a high voltage and low current during operation, approximately 2.9 amperes at 155 volts. During cold weather it is necessary to heat the lamp to 0° C. or above before it will take even a starting current. Since it is desirable to operate these lamps on standard series street lighting circuits in which a constant current is maintained, special apparatus must be provided to control the voltage and to make use of the energy which is available for each lamp.

Referring to Fig. 1 again, it will be apparent that incandescent lamp 15 being connected in multiple with the lamp 14 will be energized at the instant that the current flows in circuit 12. As stated above, the current flowing through the discharge lamp 14 at the beginning of the operation is comparatively high (5 amps.) so that a comparatively low voltage (20 v.) is obtained due to the reactance of the transformer. The incandescent lamp 15 takes a negligible amount of current at this voltage. During warm weather a discharge lamp will start very quickly and the operating current will immediately diminish thereby raising the voltage across the two lamps. When normal operating voltage (in the present instance 155 v.) is reached the incandescent lamp carries its full load current and the discharge lamp acts as a voltage regulator. The transformer 10 is designed to furnish the necessary current at the normal operating voltage for both lamps. In cold weather, however, the discharge lamp 14 will allow no current to pass so that the voltage across the two lamps will rise and energize coil 16 which, as stated above, is in multiple with the two mentioned lamps. This coil is arranged to move its armature when a predetermined voltage is reached; in the present instance at approximately 200 volts. Its contacts are thereby closed and the circuit to the third lamp 20 is established. This circuit may be traced from winding 13, through conductor 21, lamp 20, conductor 22, contacts 18 and 19, contact bar 17 and through conductor 23 to the winding 13. As long as the discharge lamp 14 does not allow current to pass, the coil 16 will maintain the circuit to lamp 20 closed. The two lamps 15 and 20 will, therefore, convert the available energy into light and can be mounted close enough to the discharge lamp to raise the temperature thereof by radiation. When the temperature of this lamp is raised, the discharge will start and the voltage across this lamp will fall to a low value, e. g. 20 volts, thereby reducing the current in coil 16 which drops the contact bar 17 and disconnects the incandescent lamp 20. As this discharge lamp 14 then reaches normal operating conditions the voltage again rises and the incandescent lamp 15, which remains in the circuit, again reaches full brilliance and the discharge lamp acts as a voltage regulator therefor.

Fig. 2 is a modification of Fig. 1 in which a relay 25 is provided with a coil 26 connected in series with the incandescent lamp 15. When the lamp 15 burns out or is broken, the circuit to the discharge lamp 14 is opened and a safety film

cutout 27 connected across the winding 13 breaks down and short circuits the winding 13.

Fig. 3 is another modification in which the discharge lamp 14 is connected across a secondary winding 30 having a low voltage tap 31 across which the incandescent lamps 15 and 20 are connected. The relay coil 26 in this figure operates two contact bars 32 and 33. When the lamp 15 is energized, the coil 26 is also energized and establishes a circuit to lamp 14 by means of its contact bar 32 and to coil 16 by means of its contact bar 33.

The circuit to the incandescent filament lamp 15 may be traced from winding 30 to conductor 34, relay coil 26, lamp 15, conductor 21 to tap 31 on the winding 30. The circuit to the discharge lamp 14 may be traced from the winding 30 through the conductor 35, the lamp 14, the conductor 36, the relay contacts 37 and 38, the bar 32, the conductor 34, to the opposite terminal of the winding 30. By this means each lamp 15 and 14 may be operated at its most efficient voltage and the actual division of power between the lamps remains the same as in the previous circuits as illustrated in Figs. 1 and 2.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In combination, a transformer having a substantially constant current primary circuit, an electric discharge lamp having a variable energy demand during starting and operating periods and an incandescent filament lamp, said lamps being connected to said transformer in multiple whereby the substantially constant current available from said transformer is proportioned between said lamps.

2. In combination, a transformer having a substantially constant current primary circuit, an electric discharge lamp having a high current starting characteristic and a low current operating characteristic and an incandescent filament lamp, said lamps being connected to said transformer in multiple whereby the available power is proportioned between said lamps during the starting and operationg periods of said discharge lamp.

3. In a lighting unit, the combination of a transformer having a substantially constant current in its primary winding, an incandescent filament lamp and an electric discharge lamp connected in multiple across the secondary of said transformer, a second incandescent filament lamp and means for automatically connecting said incandescent lamp in multiple when said discharge lamp fails to start.

4. In combination, a transformer having a substantially constant current primary circuit, a secondary winding, an electric discharge lamp, an intermediate voltage tap on said secondary winding, an incandescent filament lamp connected thereto, and means responsive to current flowing through said incandescent lamp for connecting said discharge lamp across said secondary winding.

5. In combination, a transformer having a substantially constant current primary circuit, a secondary winding, an electric discharge lamp, an intermediate voltage tap on said secondary winding having an incandescent lamp connected thereto, means responsive to current flowing in said incandescent lamp for connecting said discharge lamp across said secondary winding, and means responsive to an increase in voltage above the operating voltage of said discharge lamp for connecting a second incandescent filament lamp in multiple with said first incandescent filament lamp.

WILLEM F. WESTENDORP.